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slopes of the valley on either side from the water-line upwards. Their submergence is evidently, therefore, a matter of quite recent date, even historically speaking.

From the above facts and traditions I reconstructed the history of the formation of the cascades, the damming and backing up of the stream above, and the consequent submergence and killing of the trees which grew immediately along its bank, as follows:—

At the time when the general cutting of the Columbia valley had reached about the level of the present flood-plain at the Cascades, through some crack or other natural opening its waters found a passage into the underlying conglomerate bed, which, being permeable, allowed a passage of this water down stream to a point in the bed itself where it outcropped at or above the level of the lower part of the stream. Such a passage, once established, would be rapidly enlarged by the force of such an overlying mass of water as the Columbia River; and to those familiar with the corradng force of water, as shown in the stream-action of western rivers, it must readily be apparent that it would soon become large enough to take in the whole stream; that thus for a certain distance the whole Columbia would run underground, like the so-called 'Lost Rivers,' which are still found under the basalt flows of the Snake River plains. Thus would have been formed the natural bridge spoken of by the Indians. Moreover, by this lowering of its bed at this point, the bed of the river above would have been correspondingly lowered, and tree-growth would have gradually extended down to the water's edge, as it does at present.

Meantime the corrasion of this underground stream would gradually wear away the supports of the overhanging sheet of basalt, until at length they became inadequate to hold it up; and when they fell, the underground passage would have been suddenly filled, the river dammed up to the present level, and the stream also backed up so as to cover the roots of and thereby kill the trees along the lower part of its banks. Such is essentially the present condition of the stream: for the broken masses of the basalt which form the present stream-bed at the Cascades resist the wearing-away of the water better than did the conglomerate, and the river above the Cascades still stands at a higher level than it did before the falling-in of the basalt bridge.

I must admit the possibility that an actual survey of the region about the Cascades might disclose facts that would make the above explanation inadmissible, since it is founded on a very hasty and superficial examination. In spite of the fact of Captain Dutton's later and possibly more thorough examination than my own (for I have not been there since 1870), I am not quite willing to yield my theory in favor of his, for the reason that his theory involves what seems to me a geological improbability, — one which, in my experience at least, has not been supported by any observed facts. This is, that an earth movement — for such the flat anticlinal arch he assumes to account for the raising of the old flood-plain below the Cascades involves — could have proceeded more rapidly than the corrasion of as large a stream as the Columbia, so as to actually dam it up, and then have conveniently stopped, so as to allow corrasion to gain its former ascendancy over the earth-movement.

S. F. EMMONS.

Washington, Feb. 8.

A carnivorous antelope.

A few months ago, while visiting a friend on a cattle-ranch in the San Andreas Mountains of southern New Mexico, I saw what to me seemed a most abnormal habit. My friend had a young antelope six or seven months old, which he had captured when very young, and kept as a pet about the ranch. This animal is, by the way, very tame, following its master about without once offering to join its fellows, which often come in sight of the house. When offered pieces of raw beef, it will eat the meat with evident relish, and in preference to vegetable food. I have seen it eat piece after piece until it has disposed of half a pound or more, then it would walk to the corn-crib and eat corn as a sort of dessert. It also eats bread, cooked potato, and sweet-potato both raw and cooked.

RALPH S. TARR.

Cambridge, Feb. 14.

Language-teaching.

The important subject of the teaching of modern languages having been discussed in the columns of *Science*, and no definite plans having been offered by either of the writers discussing it, perhaps the original and independent views of a practical teacher will not be unwelcome.

It is obvious that a complete knowledge of a language consists, 1°, in having full command over the bodily organs through which it is either received or communicated to others, — viz, the vocal organs, ears, and eyes, — so as to be able to utter any sound like a native, to understand all that he says, and to read any book aloud in the proper manner; 2°, in mastering those fundamental rules of grammar — including those of the verbs — indispensable in order to speak and write correctly; 3°, in the possession of a fund of words and idiomatic forms for the expression of ideas; and, 4°, in the power of using these words and forms according to the special genius of the language studied.

Sounds of the human voice are the vibrations of an expired current of air, produced by the vocal organs, which (in the case of the French pronunciation) are, for the formation of every sound, in a fixed and determined position. In my book on pronunciation, 'French orthoepy,' I have indicated the relative positions of the vocal muscles for every French articulation and vowel. The learner is trained, by means of different vocal exercises, to use the instrument of speech in exactly the same manner as the natives; and, employing the same means, he must necessarily obtain the same result. These gymnastics of the voice are accomplished in a few short hours, and are an indispensable preliminary exercise before commencing the study proper of the language.

Teaching a language without the few fundamental rules that regulate it, including those of the verbs, is depriving the student of a most valuable aid and guide; while making grammar the all-important subject, especially in the beginning, is to create a confusion in his mind, and to impede his progress. I have taken a middle course; and in my grammar will be found, in a concise form, only those general rules without which nobody can either speak or write properly. My grammatical exercises have been framed with the view of initiating the learner into the idioms and construction of the language. To avoid those disconnected and commonplace phrases

generally found in French grammars, I have treated, in each of those exercises, one special subject.

I have made a synoptic table of thirteen lines, by which all verbs, regular or irregular, are conjugated, thus saving the student the monotony and annoyance of studying the verbs from memory by a new combination and arrangement. The student is thereby saved loss of time in writing endless conjugations of verbs.

To make attractive and instructive a study which is too often wearisome and sterile, I have given, in the third volume of my series, a vocabulary, divided into chapters, each containing an interesting outline of stories bearing on a special subject, and comprising a list of the most useful and important words of the language in daily use. Thus a natural chain of ideas is formed, easily remembered, and which can be made the subject of a conversation and composition, the student gaining in this way a thorough knowledge of the practical framework of the language. As soon as the student knows a few words of the vocabulary, these outlines are made the subjects of conversations between teacher and pupils, and, later on, between the pupils themselves. They are also employed in the form of narratives, by joining them together; and, by degrees, they are enlarged upon more and more. The fourth volume of my series, 'The modern French method,' comprises a series of words, idioms, and proverbs, forming skeleton narratives of travel, incident, and scenes, — romantic, dramatic, and comic, — all fitted to elevate the mind and inspire noble thoughts: there are also sketches in geography, biography, and history to be used in conversation and composition. By the study of this work, the learner acquires the framework, words, and idioms for literary style; and as every word, idiom, and proverb is properly located, the student will comprehend all their bearings by the context, and will know how to use them in their full meaning. A vast number of idiomatic questions are put upon the above-mentioned outline, and the answers are furnished by the student from the skeleton, or framework, upon which he enlarges at will. In order that the learner should acquire self-reliance, and be able to express himself freely on literary subjects, and should get an elegant style of his own, he sets down in narrative form each lesson previously treated conversationally, by which means he can give free play to his imaginative faculties.

The pupil, being constantly imbued with French ideas, and accustomed to look at things from a French point of view, adapts himself to them, and necessarily expands his mental vision: and as a great number of the subjects he treats of arouse his moral sensibility, and are fitted to excite in his heart tender compassion, brotherly love, devotion to his fellows, and self-denial, his moral capacities must be, as a matter of course, enlarged. This method is easy and simple, interesting, natural, and practical; and it relieves the student from much irksome and monotonous labor. It trains the ear to the apprehension of the spoken language, and, by a systematic training of the vocal organs, gives to the speaker a faultless Parisian pronunciation. The pupil is presented with a vocabulary so constructed that all the words, idioms, and proverbs form an intelligible outline of scenes and sketches, which the mind grasps and retains, while bringing out fully their individual and conventional meanings. The pictures are made so vivid and obvious, and the words are so

suggestive, that the memory is greatly assisted, and the acquirement of a stock of words becomes a mere pastime. These words are fixed in the mind of the student by frequent and pleasant repetition, and thus memory is cultivated without straining; while, by means of idiomatic questions, eliciting appropriate answers, the learner is made acquainted with the peculiar genius of the French language. No English is either written or uttered during the course. The pupil finds in the book ample English explanations, and is never left in the dark; yet by degrees he becomes accustomed to think in French.

JOSEPH D. GAILLARD.

New York, Feb. 11.

Inertia-force.

In *Science* of Feb. 11 Professor MacGregor has very courteously criticised my use of the idea which I have sought to express by the term 'inertia-force' in a pamphlet recently published. Professor MacGregor misunderstands me, however — or I misunderstand him. He quotes from my pamphlet the following passage: "If one of the opposing applied forces is greater than the other, the greater will prevail, and a change of motion will occur, occasioning an inertia-force, which will work *with* the smaller applied force *against* the greater," and then says, "The inertia-force, therefore, is supposed to act on the body by which it is exerted."

I am at a loss to understand how Professor MacGregor makes this inference from the passage he quotes. I meant that the inertia-force works ('acts' would be a better word) with the smaller applied force *against the agent which* exerts the greater force. Take this example: a train is being started by a locomotive. The forces *applied* to the train are the pull of the locomotive, and the smaller, opposing, force of friction. The pull of the locomotive prevails, but in prevailing it must deal not only with the resistance due to friction, but with the reaction (which also I call resistance) due to the inertia of the train. The friction resistance would be nearly the same whether the acceleration of the train were great or small; but the resistance due to inertia, the *inertia-resistance*, or *inertia-force*, would be always proportional to the acceleration.

The term 'centrifugal force,' although I do not like it, does not excite in me the horror which Professor MacGregor evidently thinks it should occasion. I certainly should not say that a ball swinging in a circle at the end of a string connecting it with the centre of the circle is *acted on* by 'a force directed from the centre,' but I certainly should say that the ball *acts upon the string* with 'a force directed from the centre,' — a proposition which seems to me so plainly true that I think all difference of opinion as to its truth must arise from different interpretations of the word 'force.'

I suspect that Professor MacGregor and I do interpret that word somewhat differently. The following quotation from Maxwell's 'Matter and motion,' p. 78, seems to me to express my view with sufficient accuracy: —

"As soon as we have formed for ourselves the idea of a stress, such as the tension of a rope or the pressure between two bodies, and have recognized its double aspect as it affects the two portions of matter between which it acts, the third law of motion is seen to be equivalent to the statement that all force is of the nature of stress, that stress exists